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Amphibian Reconnaissance Surveys In the Williston Reservoir Watershed, May 1998

P. E. Hengeveld
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The Peace/Williston Fish & Wildlife Compensation Program is a cooperative venture of BC Hydro and the provincial fish and wildlife management agencies, supported by funding from BC Hydro. The Program was established to enhance and protect fish and wildlife resources affected by the construction of the W.A.C. Bennett and Peace Canyon dams on the Peace River, and the subsequent creation of the Williston and Dinosaur Reservoirs.

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1.0 Introduction

Amphibians, commonly known as frogs, toads, and salamanders, are found worldwide in a broad range of habitat types. This class of vertebrates is distinguished by its lack of scales, fur or feathers, and also by its two-phased life cycle; most amphibians metamorphose from an aquatic larval stage into a terrestrial adult stage.

Twenty-one amphibian species[1] (two introduced) have been documented in British Columbia (BC), however, baseline information on species biology, distribution, and abundance is limited (Green and Campbell 1984). Much of the data collected on BC amphibian populations results from species-specific research and inventory projects (e.g., for red and blue-listed species) concentrated in the southern part of the province, and the enthusiasm of amateur naturalists (Laura Friis, BC Environment, personal communication).

Many areas in northern, mountainous, and coastal BC have never been properly surveyed for amphibians, and the breeding habits of species in northern regions of this province are poorly known (Green and Campbell 1984). The status of amphibians in north-central BC has been derived primarily from opportunistic inventories, museum collections, and incidental sightings. The only major amphibian projects undertaken in north-central BC to date are an informal monitoring program currently underway in the Peace River region (Stan Orchard, CARCN, personal communication), and a systematic inventory of amphibians and reptiles conducted in the Prince George Forest District in 1996 and 1997 (Kinsey and Law 1998).

Wetlands in the Williston Reservoir watershed have never been systematically surveyed for amphibians. This prompted the Peace/Williston Fish and Wildlife Compensation Program (PWFWCP) to collect information on amphibian species diversity, distribution, and, if possible, relative abundance in the watershed.

Amphibian species presumed to be resident throughout the Williston Reservoir watershed include long-toed salamanders *(Ambystoma macrodactylum)*, western toads *(Bufo boreas)*, wood frogs *(Rana sylvatica)*, and Columbia spotted frogs *(Rana luteiventris)*.

[1] This total includes the Columbia spotted frog *(Rana luteiventris)*, very recently recognized as a species separate from the Oregon spotted frog *(Rana pretiosa)*.

Striped boreal chorus frogs *(Pseudacris triseriata maculatd)* are expected to be present in the Peace region, east of the Rocky Mountains (Green and Campbell 1984, Corkran and Thorns 1996, CARCN 1998). Because these species are all pond-breeding amphibians, they are most easily detected in early spring, when breeding pairs congregate at wetlands and egg masses may be observed (Thoms et al. 1997). Adult males of these frog and toad species have distinctive breeding calls, thus a combination of auditory (breeding call) and visual (aquatic) surveys are best done during the spring breeding period to maximize the potential for species detection.

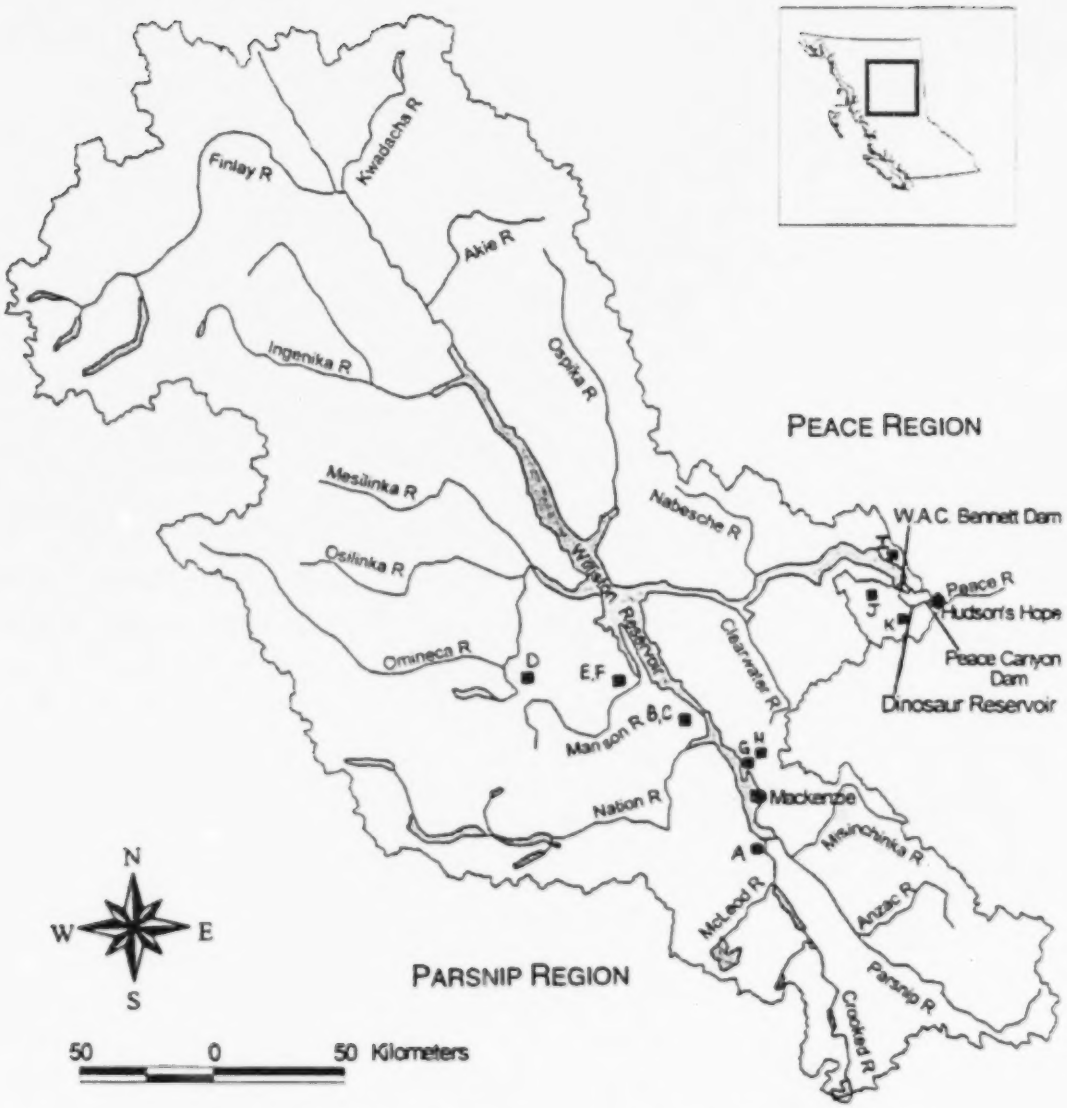
Forest management decisions are generally based on Biogeoclimatic Ecosystem Classification (BEC) units. Since the BEC system integrates climatic, site (e.g., soils), and vegetative variables -factors which may be relevant to amphibian distribution- BEC subdivisions (i.e., subzone variants) were selected as survey units.

This study documents the presence of amphibian species in BEC units in the Parsnip (southern) and Peace (eastern) regions of the watershed in May 1998. Survey results will contribute data to the provincial Conservation Data Centre inventory database for vertebrates. They will also be used to identify enhancement opportunities and to assess the potential of conducting more intensive amphibian inventories, habitat-use surveys and/or long-term population monitoring programs within the Williston Reservoir watershed.

2.0 Study Area

2.1 Williston Reservoir Watershed

The Williston Reservoir watershed is located in north-central BC, between 54 degrees and 58 degrees north latitude, and 121 degrees and 128 degrees west longitude (Figure 1; Davidson and Dawson 1990). The reservoir inundates portions of the valley bottoms of three major river drainages; the Finlay and Parsnip rivers flowing from the north and south feed the Peace River flowing east. The Williston Reservoir watershed's Parsnip River drainage will hereafter be referred to as the Parsnip region, and the Peace River drainage (i.e., east to Hudson's Hope) will be referred to as the Peace region.



■ Parsnip Region Areas & Routes

Sabai (SBSmk1) - route A
Blackwater (SBSmk2) - routes B & C
Manson (BWBSdk1) - route D
Curve Lake (SBSwk2) - routes E & F
Mugaha Marsh (SBSmk2) - route G
Mugaha Creek (SBSvk) - route H

■ Peace Region Areas & Routes

Dunlevy (BWBSmw1) - route I
Gaylard Creek (SBSwk2) - route J
Johnson (BWBSmwl) - route K

Figure 1. Amphibian reconnaissance survey areas and routes within the Parsnip and Peace regions of the Williston Reservoir watershed, May 1998. Biogeoclimatic Ecosystem Classification (BEC) units identified in parentheses.

The Parsnip region spans the wide valley of the Rocky Mountain Trench, flanked by the Omineca Mountains to the west and the Rocky Mountains to the east. The Omineca and Rocky Mountain ranges influence precipitation levels, resulting in more than 150 cm of annual precipitation on the wind-ward side and less than 50 cm of precipitation on the lee side of these ranges; about 50% of the precipitation occurring in the Parsnip and Peace regions falls as rain (Davidson and Dawson 1990). Snow begins falling in October and increases in depth until March or April. The frost-free growing period is less than 60 days in most of the Parsnip region, and less than 90 days in the Peace region; the vegetative growing season begins in mid-May along the reservoir in the Peace region and about 2 weeks later in the Parsnip region (Davidson and Dawson 1990).

2.2 *Biogeoclimatic Ecosystem Classification (BEC) zones*

The Biogeoclimatic Ecosystem Classification (BEC) system was developed by the BC Ministry of Forests to provide a framework for resource management and scientific research (Meidinger and Pojar 1991). It is a hierarchical system which integrates primarily climate, soil, and vegetation data. BEC zones are large geographic areas having a broadly homogeneous macroclimate and characteristic vegetation and soils; zones are generally named after one or more of the dominant climax vegetation species in zonal ecosystems.

Survey routes were established in areas within the Sub-Boreal Spruce (SBS) and Boreal White and Black Spruce (BWBS) BEC zones. The SBS landscape is dominated by upland coniferous forests, with wetlands being common (Meidinger and Pojar 1991). The BWBS zone is slightly cooler and generally drier than the SBS zone (Table 1). Lowlands are poorly drained and characterized by a mosaic of forest and wetland ecosystems (Meidinger and Pojar 1991). Frequent fires and insect infestations are the dominant disturbance in both the SBS and BWBS zones.

Zonal divisions (e.g., subzones and variants) reflect differences in regional climate (coded according to relative precipitation and temperature regimes), and geographic location within the zone[2].

[2] The first letter of the two letter code for BEC subzones refers to precipitation: x (very dry/xeric), d (dry), m (moist), w (wet), v (very wet). The second letter refers to temperature: h (hot), w (warm), m (mild), k (cool), c (cold), v (very cold). Variants are named by geographic area within a zone, and ordered by increasing number from south to north and from west to east. (DeLong et al. 1993).

Table 1. Climatic characteristics of lower elevation Biogeoclimatic Ecosystem Classification (BEC) units in the Parsnip and Peace regions of the Williston Reservoir watershed. Data compiled from DeLong et al. 1990, Mackinnon et al. 1990, DeLong et al. 1993, DeLong and Fahlman 1996. Values in parentheses are ranges.

BEC unit	Mean seasonal precip.[1] (mm)	Mean annual precip. (mm)	Mean annual snowfall (cm)	Mean annual temperature (°C)
SBSmkl	273 (197-432)	727 (628-838)	306 (242-356)	1.5 (-0.2 - +3.3)
SBSmk2	250 (210-295)	690 (n/a)[2]	335 (n/a)[2]	1.2 (+.07- +1.9)
SBSwk2	335 (210-535)	905 (550-1,915)	1,075 (n/a)[2]	1.0 (-0.1 - +1.7)
SBSvk	286 (227-401)	585 (520-739)	182 (180-183)	3.7 (+3.1 - +4.2)
BWBSdkl	225 (130-280)	405 (325-505)	180 (135-270)	-0.2 (-1.9 - +2.0)
BWBSmwl	290 (225-355)	485 (395-660)	190 (130-250)	1.1 (-1.2 - +2.7)

[1] Mean seasonal precipitation for the period from May to September.
[2] n/a indicates data not available.

The SBSmkl subzone occurs from the watershed's southern boundary north to Mackenzie, and in the valley bottoms from Philip Lakes north to the Manson Lakes (BC Environment 1998). It is considered to be the subzone most representative of the sub-boreal climate (DeLong et al. 1993). The SBSmk2 occurs along the Williston Reservoir, from Mackenzie north to Factor Ross Creek (BC Environment 1998); it does not occur in the Peace region. It is the driest of the SBS units in the Williston Reservoir watershed (MacKinnon et al. 1990). The SBSwk2 occurs as a narrow band between the SBSmk2 and the higher elevation Engelmann spruce - subalpine fir (ESSFmv3) zone in the Parsnip region, and along the reservoir and its tributaries in the Peace region (BC Environment 1998). The SBSvk occupies a few narrow side valleys of the Rocky Mountains, in the eastern Parsnip region. It is bordered by the SBSwk2 and the higher elevation Engelmann spruce - subalpine fir (ESSFwk2) zone (DeLong and Fahlman 1996, BC Environment 1998).

The BWBSdkl is a lowland to montane subzone (Mackinnon et al. 1990), and receives the least snow of all northern biogeoclimatic zones (Meidinger and Pojar 1991). In the Parsnip region, it extends north from the Manson and Germansen lakes, spanning the Omineca River valley (BC Environment 1998). The BWBSmwl is found only in the eastern extremity of the Peace region, occurring in a narrow band along the reservoir's north shore (DeLong et al. 1990, BC Environment 1998).

3.0 Methods

3.1 Selection of Survey Areas, Routes, and Sites

Prior to the field work, topographic, BEC, Forest Service road, and forest cover maps were reviewed to assess the distribution and accessibility of wetland areas within various biogeoclimatic subzones of the Parsnip and Peace regions of the watershed. Though the intent was to conduct amphibian surveys in a variety of BEC subzones, travel considerations (e.g., time and distance between survey areas) were a limiting factor in survey area selection. Snow and poor road conditions precluded travel to higher elevations (i.e., ESSF and Alpine Tundra BEC zones) in early May, thus potential survey areas were initially identified within 6 subunits of the lower elevation BWBS and SBS zones. The aim was to survey at least one area in each subzone, allotting one day to survey each area. The suitability of each potential survey area was evaluated as field work progressed.

Secondary gravel Forest Service roads (FSR) were adopted as transect routes within each survey area. Afternoon field work involved traveling the selected route, checking both sides of the road for potential breeding call and/or aquatic survey sites. Call survey sites were chosen subjectively to assess species' presence at likely breeding sites. Wet areas in close proximity to the road, and with little or no running water present, were considered optimal and favoured for surveying. Sites with running water were considered difficult to survey, as the sound can obscure vocalizations; these sites were therefore only surveyed when a small number of optimal sites were available along a particular route. Appropriate aquatic survey sites were considered to be any water body or meadow on Crown land, accessible from the road, and complex enough to warrant a search (i.e., of reasonable size and with some debris or vegetation). Field personnel (M. Wood and P. Hengeveld) noted the mileage at which each site was located, using the truck odometer to monitor distance traveled. Occasionally, sites were marked with flagging tape.

Transect route length and the number of survey sites selected per route varied among areas. Routes with relatively few suitable survey sites were longer than those with an abundance of wetland sites. In some areas, two routes were traveled to increase the total number of survey sites. The aim was to conduct a minimum of 5 breeding call surveys and 2 aquatic surveys per area.

3.2 Survey Techniques

There are several standard survey techniques recommended for detecting amphibians (Heyer et al. 1994, RIC 1997, NAAMP 1998). Utilizing a combination of techniques maximizes the potential of detecting all species present in an area. The adult males of three species (western toad, wood frog, and spotted frog) expected to occur, and one species (striped chorus frog) which may potentially occur in the survey areas are known to be distinctively vocal during the breeding period, thus the evening breeding call survey was selected as the primary survey method. Aquatic surveys complement call surveys as they enable detection of non-vocal individuals (e.g., females) and species (e.g., long-toed salamanders), as well as egg masses and larvae.

Two weeks were allocated to conducting amphibian reconnaissance surveys, timed to coincide with the anticipated breeding period of amphibian species expected to occur in the watershed. Prior to the planned survey start date, updates on local weather conditions and ice-melt were obtained from residents near the proposed survey areas. Reports of ponds still covered with ice and persistent snow on access roads postponed the projected survey period by one week, and prompted the decision to conduct field work in the Parsnip region during Week 1 (11-14 May) and in the Peace region during Week 2 (19-21 May).

For reconnaissance-level surveys the emphasis is on recording survey time and duration, species identification, and site location. Species identity was confirmed using the keys and descriptions in Corkran and Thoms (1996). Frog and toad breeding call recordings were also useful references: 'The Amphibians and Reptiles of Alberta' recorded by Cliff Wallis/Cottonwood Consultants (Calgary, AB), and recordings made by Sandra Kinsey (Prince George, BC). Amphibian activity is influenced by ambient conditions, thus weather and temperature (both air and water) data were noted. Site photographs were taken, and UTM co-ordinates (NAD83) were determined for each site using a Trimble Flightmate Pro hand-held Global Positioning System (GPS) unit. Habitat data (i.e., description of the aquatic substrate, type and amount of aquatic vegetation, shoreline characteristics, and general surroundings) were collected to provide some rudimentary indication of the relative importance of various site attributes to amphibian presence. Data forms and a list of equipment used for the breeding call and aquatic surveys are included in Appendix A.

3.2.1 Breeding Call Surveys

Survey routes were traveled by vehicle between dusk and midnight. At each previously identified call survey site, the vehicle was stopped and the ignition was turned off. Two observers (M. Wood and P. Hengeveld) stood on the road to listen, recording all amphibian calls heard within a standard 3 minute survey period (NAAMP 1998). Both the species heard and the call frequency code[3] were noted. Amphibian calls heard after 3 minutes had elapsed, as well as other wildlife heard or observed during the survey were also noted. Air temperature and relative wind force were recorded.

While driving from one call survey site to the next, both observers watched for amphibian presence on the road, noting both species and location of any individuals observed. At travel speeds of 30 km/hr or less, road surveys can be particularly useful for detecting toads, and potentially salamanders, on their nocturnal migrations to and from breeding ponds (RIC 1997; Sandra Kinsey and Laird Law, Alpine Environmental Services, personal communication).

3.2.2 Aquatic Surveys

Aquatic surveys were conducted by two observers (M. Wood and P. Hengeveld) between 1300 and 1900 hrs, when amphibians are likely to be most active and observable (Sandra Kinsey and Laird Law, Alpine Environmental Services, personal communication). In general, the two observers searched separately at each site to maximize the area surveyed, assisting each other only when a specimen had been found. Observers searched portions of the shoreline and waded in shallow water areas, checking vegetation and turning over rocks and woody debris in an effort to find eggs, larvae, and adults (cf. NAAMP protocol and RIC guidelines). Specimens were captured with aquarium dipnets and placed individually in a plastic bucket when necessary for species identification and photography. Snout-to-vent (SVL) length was measured with a small plastic ruler, and mass was determined using a 100 g Pesola spring scale.

[3] The frequency of calls is recorded as 0 (no calls heard), 1 (no overlap in calls from a single species), 2 (calls of one species are overlapping but distinct), or 3 (full chorus of one species; calls continuous and overlapping, individuals not distinguishable).

4.0 Results

Fifty-eight (58) breeding call surveys and 21 aquatic surveys were conducted along 9 of the 11 routes identified, from 11 to 21 May 1998 (Table 2). Surveys were completed in 7 survey areas, 4 in the Parsnip region and 3 in the Peace region, representing 5 biogeoclimatic subunits of the SBS and BWBS zones. Survey routes ranged from 1.5 to 26.8 km in length; the location and a general description of each route are provided in Appendix B. An attempt was made to sample sites in the Mugaha Creek (SBSvk) and Dunlevy (BWBSmwl) survey areas, but a lack of adequate wet or moist sites along selected routes in these areas precluded any breeding call or aquatic surveys.

Weather conditions were quite variable during the survey period (Table 3). Afternoon temperatures ranged from 15°C to 26°C, and winds were light to strong. Evening temperatures ranged from 3 °C to 12°C, with winds generally calm to light.

Table 2. Areas, routes, and sites surveyed in the Parsnip and Peace regions of the Williston Reservoir watershed, 11-21 May 1998.

Region	BEC unit	Date	Survey area	Route	Route length (km)	Survey sites: Breeding call	Survey sites: Aquatic
Parsnip	SBSmkl	11-May	Sabai	A	26.8	14 (A1-A14)	3 (A1,A6,A11)
	SBSmk2	12-May	Blackwater	B	17.3	6 (B1-B6)	3 (B1,B3,B4)
				C	10.4	0	1 (C1)
		19-May	Mugaha Marsh	G	1.5	3 (G1-G3)	1 (G2)
	SBSwk2	14-May	Curve Lake	E	6.8	10 (E1-E10)	3 (E1,E3,E7)
				F	3.2	4 (F1-F4)	1 (F1)
	SBSvk	20-May	Mugaha Crk	H	5.3	0	0
	BWBSdkl	13-May	Manson	D	25.0	11 (D1-D11)	5 (D1,D2,D4, D10,D11)
Peace	SBSwk2	20-May	Gaylard Crk	J	16.0	3 (J1-J3)	2 (J1,J3)
	BWBSmwl	20-May	Dunlevy	I	15.0	0	0
		21-May	Johnson	K	21.0	7 (K1-K7)	2 (K4,K6)
Total				11	148.3	58	21

Table 3. Weather conditions during the PWFWCP amphibian reconnaissance surveys, 11-21 May 1998.

Route	Date	Survey time (hrs)	Cloud cover[1] (%)	Wind condition	Temp. (°C) min	Temp. (°C) max	Comments
A	11 May	1610-1910	10-30	light	19	25	
		2215-0130	0	calm	9	12	
B,C	12 May	1510-1910	85-95	light			intermittent showers
		2155-0040	20-90		8	12	
D	13 May	1345-1845	40-80	light-strong	18		
		2135-0010	90-100	light-strong	4		light rain began at midnight
E,F	14 May	1445-1850	15-50	light	15	18	
		2140-0025	0-95 (thin)		3		sunset just after 2100 hrs, with daylight waning by 2215 hrs
G	19 May	1400-1535	25	light-strong		22	sunny
		2145-2230	0	calm			
J	20 May	1525-1710	10	light-strong		26	
		2205-2240	5	calm	10		
K	21 May	1530-1815	40-70	light-strong		24	thundershowers developing
		2205-2325	0	calm-light		10	

[1] Cloud cover is based on subjective estimate by observer.

4.1 Breeding Call Surveys

Amphibian breeding calls were identified at 14 of the 58 sites surveyed. No breeding choruses were heard; call frequency at 4 sites was overlapping but distinct, and only individual calls were detected at the other 10 sites (Table 4). Calls from at least one western toad, wood frog, or Columbia spotted frog were detected along each survey route in the Parsnip region during the 11-14 May period. One individual heard calling at site B1 on the Blackwater route may have been a wood frog, but species identity could not be confirmed. No amphibian breeding calls were detected at selected sites in the Peace region or at Mugaha Marsh (route G, Parsnip region) during the 19-21 May period.

While traveling between call survey sites, PWFWCP personnel observed 40 western toads: 32 on the Blackwater Lake 14000 road (route B, SBSmk2), 7 on the Finlay N39000 road (route E, SBSwk2), and 1 on the Johnson FSR at Elizabeth Creek (route J, SBSwk2). No amphibians were observed while traveling along the Sabai (A), Manson (D), Mugaha (G), and Johnson (K) routes. Road survey efforts were not consistent among routes, as travel speed and visibility varied with topography and weather conditions.

Table 4. Frequency of amphibian calls heard during breeding call surveys conducted in the Parsnip and Peace regions of the Williston Reservoir watershed, 11-21 May 1998. Values in parentheses refer to the survey site at which calls were detected.

Region	BEC unit	Route	Date	Breeding call frequency[1]		
				BUBO[2]	RASY[2]	RALU[2]
Parsnip	SBSmk1	A	11 May	1(A3), 2(A2)		1 (A6, A14)
	SBSmk2	B	12 May	1(B6), 2 (B3)	1(B3)	1(B6)
		G	19 May			
	SBSwk2	E	14 May	1(E5)	1(E7)	
		F	14 May		1(F2)	
	BWBSdk1	D	13 May	1(D2)	1 (D4, D9, D11), 2(D2, D3)	1 (D2, D3)
Peace	SBSwk2	J	20 May			
	BWBSmw1	K	21 May			

[1] Breeding call frequency: 1 -no overlap in calls from a single species, 2 -calls of one species are overlapping but distinct.

[2] Species: western toad *(Bufo boreas,* BUBO); wood frog *(Rana sylvatica,* RASY); Columbia spotted frog *(Rana luteiventris,* RALU).

4.2 Aquatic Surveys

A total of 26.4 person-hours were spent searching a variety of wetland types in clearcut, forested, and riparian habitats. The 21 aquatic surveys confirmed the presence of western toads, wood frogs, Columbia spotted frogs, and long-toed salamanders at multiple locations in the Parsnip and Peace regions of the Williston Reservoir watershed (Table 5). During Week 1 (11-14 May) in the Parsnip region, long-toed salamander, western toad and Columbia spotted frog eggs were observed, along with juvenile (one year old) toads, and adult toads, wood frogs, and spotted frogs. In the Peace region during Week 2 (19-21 May), western toad tadpoles were observed, along with juvenile and adult toads, and adult wood and spotted frogs.

Aquatic survey sites ranged from ephemeral flood and seepage areas to large, permanent water bodies (Appendix C). Water temperature at the sites surveyed ranged from 8-24°C (Appendix C). Juvenile and adult frogs and toads were present at sites with temperatures from 10 to 22°C, while long-toed salamander, western toad, and spotted frog eggs were present in water temperatures of 16 to 19°C. Tadpoles (western toad) were only observed at the 3 sites having water temperatures $\geq$20°C (i.e., sites G2, J3, and K4).

Table 5. Amphibians observed during aquatic surveys conducted in Biogeoclimatic Ecosystem Classification (BEC) units within the Parsnip and Peace regions of the Williston Reservoir watershed, 11-21 May 1998.

BEC unit	Route (Survey Area)	Site	Search Time[1] (hrs)	Species[2]	Number Observed E[3]	T[3]	J[3]	A[3]
SBSmk1	A (Sabai)	1	1.3					
		6	2.0	BUBO			4	
		11	1.3	BUBO				1
				AMMA	~15			
SBSmk2	B (Blackwater)	1	0.8					
		3	1.8	BUBO			2	6
		4 *(i)*	1.0	BUBO				1
				AMMA	20-30			
		4 *(ii)*						
	C (Blackwater)	1	0.2	AMMA	1			
	G (Mugaha Marsh)	2	3.2	BUBO		>1000	2	1
				RALU				1
SBSwk2	E (Curve Lake)	1	1.3					
		3	0.8					
		7	1.2					
	F (Curve Lake)	1	0.6					
	J (Gaylard Creek)	1	1.2	RASY				1
		3	1.3	BUBO		>100		
BWBSdk1	D (Manson)	1	1.2					
		2	1.7	RALU	>3			1
				BUBO	>10			>3
		4	0.8	RALU	10-15			
				RASY				1
		10	0.4					
		11	0.7					
BWBSmw1	K (Johnson)	4 *(i)*	2.0	RALU				1
		4 *(ii)*		BUBO		1		
		4 *(iii)*		BUBO		>1000		
		6	1.8	BUBO			6	
				RASY				4

[1] Total search time at each site, expressed in person-hours.

[2] Species: long-toed salamander *(Ambystoma macrodactylum,* AMMA); western toad *(Bufo boreas,* BUBO); wood frog *(Rana sylvatica,* RASY); Columbia spotted frog *(Rana luteiventris,* RALU).

[3] Life stage: eggs (E) -numbers refer to clusters of AMMA eggs, strings of BUBO eggs, and masses of RASY or RALU eggs; tadpoles (T); juveniles (J) -young born the previous year; adults (A). Abundance was based on direct counts or minimum estimates.

Thirty-five metamorphosed individuals (26 western toads, 6 wood frogs, and 3 Columbia spotted frogs) were observed during the aquatic surveys. Mass and length measurements were obtained for 16 metamorphosed individuals (13 western toads, 2 wood frogs, and 1 spotted frog) and averaged from several western toad tadpoles (Appendix D). Western toad snout-to-vent lengths (SVL) ranged from 16 to 28 mm for juveniles (n=9) and 65 to 100 mm for adults (n=4); mass was less than 1 g for juveniles and ranged from 29 to 98 g for adults. Toad tadpoles measured 4-5 mm SVL with a 5 to 6 mm tail. Two wood frogs were captured, measuring 22 and 55 mm SVL, and weighing 2 and 14 g respectively. A single spotted frog was measured, having a SVL of 67 mm and weighing 25 g. All captured amphibians were held individually and promptly released after measurements had been taken.

4.3 Incidental Amphibian and Other Wildlife Sightings

Scott Muller (Germansen Landing resident, personal communication) recalled first hearing and seeing frogs at Germansen Landing (BWBSdk1) in the last 2 weeks of April 1998. He also reported that a pair of long-toed salamanders were resident under woody debris at the Germansen Landing store, however they could not be located when this site was surveyed by PWFWCP personnel on 13 May 1998. Several other incidental amphibian sightings within the Williston Reservoir watershed, including western toad and wood frog records for a BEC unit (BWBSwk1) not surveyed by the PWFWCP, were reported throughout the spring and summer of 1998 (Table 6).

A variety of passerines, waterfowl, owls and other birds were incidentally recorded while conducting the PWFWCP amphibian breeding call and aquatic surveys (Appendix E).

Table 6. Incidental amphibian sightings in the Williston Reservoir watershed, June-August 1998.

BEC unit	Date	Time (hr)	Location	Species[1]	Number observed			Observer
					T[2]	J[2]	A[2]	
SBSmk1	4 Jun	1710	Roadside seepage area at 6.5 km on the Wolverine 5000 FSR	RALU			2	F. Corbould
				unidentified	~400			
	4 Jun	1710	Searched roadside ponds between 5.8 and 15 km on the Wolverine 5000 FSR	None				F. Corbould
	5 Jun	1550	Roadside ditch at 2.9 km on the Manson 12000 FSR	unidentified	1000-2000			F. Corbould
SBSmk2	3 Jun	0910	Small seepage area at 1 km on the 1000 FSR	RALU			1	F. Corbould
	5 Jun		Small seepage area at 1.3 km on Bug Lake Rd	RALU			1	F Corbould
	6 Jun		Stranberg roadside area	unidentified frog			1	F. Corbould
	6 Jun		Stranberg tributary	BUBO		2		F. Corbould
				RASY		1		
SBSwk2	23 Jul	1930	At the confluence of the Nabesche River and an unnamed creek, SW of Mt. Brewster	BUBO			2	P. Hengeveld
BWBSwk1	22-24 Aug		Ruddy Crk (Butler Ridge)	RASY			1	M. Wood
				BUBO		3		

[1] Species: western toad *(Bufo boreas,* BUBO); wood frog *(Rana sylvatica,* RASY); Columbia spotted frog *(Rana luteiventris,* RALU).

[2] Life stage: tadpoles (T); juveniles (J) - young born the previous year; adults (A). Abundance was based on direct counts or observer estimates.

5.0 Discussion

The PWFWCP amphibian reconnaissance surveys confirmed the presence of 4 of the 5 species expected to occur in the Parsnip and Peace regions of the Williston Reservoir watershed: long-toed salamander, western toad, wood frog, and Columbia spotted frog. Western toads, wood frogs, and Columbia spotted frogs were detected at sites in both regions. Long-toed salamanders were detected at sites in the Parsnip region only. Striped chorus frogs, known to occur in north-eastern BC (Green and Campbell 1984, Corkran and Thoms 1996), were not detected at the sites surveyed.

The non-detection of salamanders in the Peace region may be a reflection of low survey intensity, rather than an indication of salamander absence from the region. Since long-toed salamanders are non-vocal, only one of the survey methods utilized (i.e., aquatic surveys) targeted this species. The adults are shy, nocturnal, and largely terrestrial, thus aquatic surveys are most likely to detect the presence of eggs or larvae. The eggs, laid individually or in small clumps, might easily be missed during a survey. The larvae tend to stay congregated where the eggs are laid and may be easier to find than eggs, but larvae could also be missed if the site is not searched completely (Mark Thompson, Calgary, Alberta, personal communication).

Of the two survey methods utilized by the PWFWCP, breeding call surveys were the primary method targeting striped chorus frogs. This species is very small and is not likely to be detected unless individuals are heard calling (Corkran and Thorns 1996). It is possible that chorus frogs were present in the Peace region but not detected due to the absence of breeding calls at the time of the survey (20-21 May).

The success of breeding call surveys is dependent on optimal survey timing. Breeding calls were heard in the Parsnip region during 11-14 May, but not at Mugaha Marsh or in the Peace region during 19-21 May. Similarly, eggs (long-toed salamander, western toad, and Columbia spotted frog) were observed only in the Parsnip region, 11-14 May, while tadpoles (western toad) were detected only at Mugaha Marsh and in the Peace region, 19-21 May. Since spring conditions generally arrive earlier in the Peace than in the Parsnip region, it is reasonable to expect peak amphibian breeding activity to start and end earlier in the Peace region. The difficulty is that although all 5 amphibian species in the Williston Reservoir watershed are pond-breeders and mate in the spring, there is variation in both the timing and length of each species' breeding period, as well as annual variation in the onset of the breeding period.

The majority of the amphibians observed and captured were juvenile and adult toads. Many of these were observed on the Blackwater road at the time of the evening breeding call surveys; mass migrations of toads to and from breeding sites are not uncommon on dark, wet nights (Cook 1984). Wood frog and Columbia spotted frog adults were heard more often than seen. Spotted frogs tend to remain hidden in submerged vegetation and may therefore be difficult to find, and adult wood frogs disperse rapidly from breeding sites (Cook 1984). Only western toad tadpoles were observed. The larvae (i.e., tadpoles) of this species characteristically travel in swarms, making them conspicuous at a site,

while wood frog, spotted frog, and long-toed salamander larvae tend to be more dispersed and/or cryptic. Also, the toad tadpoles may have been more developed than other larvae potentially present (but not detected) at other survey sites. The tadpoles were observed in the 3 warmest sites surveyed; western toad development is particularly sensitive to ambient conditions and larvae develop faster in wanner temperatures (Cook 1984; Jay Bowerman, Sunriver, Oregon, personal communication).

Long-toed salamanders, western toads, wood frogs, and Columbia spotted frogs occurred in both the SBS and BWBS biogeoclimatic zones, though not all were detected in each BEC subunit. The combination of breeding call surveys, aquatic surveys and incidental reports confirmed the presence of all 4 species in both the SBSmk2 and BWBSdkl subunits. BEC zones are useful as a sampling unit for determining landscape-level distribution, but there is considerable variation in subunit and site variables. This variation is compounded by variability in species detection and weather conditions, thus with low sampling intensity, it is difficult to derive any conclusions about the apparent absence of a species from a survey area (e.g., BEC unit) or site (e.g., wetland type). It is possible that survey sites where no amphibians were detected were not optimal habitats and that more favourable sites were present in adjacent, non-surveyed wetlands. At sites which were only partially surveyed (due to time or access limitations), amphibians may have been present in the portions not surveyed. The effect of weather conditions on amphibian activities is also difficult to assess for single-visit reconnaissance surveys since seasonal and annual climatic variations must be monitored in order to see emergent phenological patterns.

There is too much variation inherent in low-intensity reconnaissance-level surveys to enable an evaluation of amphibian species' relative abundance. Systematic breeding call surveys can provide an index to the relative abundance of calling amphibians at and among sites, when conducted during the peak breeding period (Zimmerman 1994, Bishop and Shirose 1998). However, scheduling a single-visit survey to coincide with peak breeding activity at each site may not be possible. Relative abundance estimates based on direct counts obtained during the aquatic surveys require a more intensive methodology (e.g., total-area or fixed-area searches) to enable comparison of the number of species and individuals encountered per site.

In addition to meeting the reconnaissance survey objectives (i.e., determining amphibian species presence in various BEC units within the Parsnip and Peace regions), the survey results provide insight to the value and requirements of more intensive inventories and monitoring programs. Repeated surveys throughout the rise and fall of calling activity can help observers identify the peak breeding period at a site (or comparable developmental period among sites), and can also provide useful breeding phenology data (i.e., the influence of climate on the timing and length of the reproductive period) if weather data is documented concurrently. Due to the highly cyclical nature of amphibian populations (Johnson 1992), it is impossible to speculate on the recruitment and health of local populations based on the results of a single survey. While reconnaissance-level surveys are sufficient to provide basic species presence information at one point in time, a more rigorous inventory would be required to provide data about a species' habitat requirements and population characteristics. Longer-term monitoring programs would enable detection of changes in species abundance, composition, and diversity over time, and as such are vital to assessing the status of a population.

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Appendix A Data forms and a list of equipment used for the aquatic and breeding call surveys.

Maps (topographic and Forest Service recreation maps)
Amphibian live-capture permit
Thermometer for water temperature
Maximum/minimum thermometer for air temperature
pH meter
Distilled water and squeeze bottles to rinse pH meter between aquatic survey sites
Aquarium dip nets to capture amphibians
4L plastic bucket to hold captured amphibians (if necessary)
Pesola spring scale (100g)
Ziploc sandwich bags suspended from spring scale to enable weighing of individuals
6" plastic metric ruler for SVL measurements
Stopwatch to time the call surveys
Flagging tape to mark survey sites (if necessary)
Camera
Photo film
Hipwaders, rubber boots
Scrub brush and "camp suds" to clean boots, nets, etc. between aquatic survey sites.
Identification guides
Amphibian call tapes
Waterproof notebooks
Data forms
Pencils
Hand-held GPS unit
Hand-held radios
Bear spray
Flashlights
Extra batteries
First Aid kit

PWFWCP AMPHIBIAN SURVEY DATA FORM Auditory survey

DATE_____START_____END_____OBSERVERS_____

WEATHER SKY clear | overcast (%) | rain_____
WIND calm | light | strong [Beaufort wind scale_____]
AIR TEMP_____24hr max & min_____

SITE#_____
SITE LOCATION (km on road)_____
_____
SITE ORIGIN natural / man-made_____Dist from road (m)_____
SITE SIZE (m) length_____width_____depth_____

ELEVATION_____ BEC ZONE_____variant_____
MAP_____UTM ZONE_____NORTHING_____EASTING_____

SURROUNDING HABITAT, FOREST TYPE/AGE_____
_____

	SPECIES	CODE	# ADULTS	COMMENTS	TAPE #
Three					
minute					
interval					

Code: 0= nothing heard; 1= individual calls; 2= some overlap of calls; 3= continuous chorus

Notes, Other species heard:_____

PWFWCP AMPHIBIAN SURVEY DATA FORM Visual site survey

DATE_____START_____END_____OBSERVERS_____

WEATHER SKY clear | overcast (%) | rain_____
WIND calm | light | strong [Beaufort wind scale_____]
AIR TEMP_____24hr max & min_____

SITE#_____
SITE LOCATION (km on road)_____
_____
SITE ORIGIN natural / man-made_____PHOTOS_____
SITE SIZE (m) length_____width_____depth_____
WATER TEMP_____WATER pH_____

ELEVATION_____BEC ZONE_____variant_____
MAP_____UTM ZONE____NORTHING_____EASTING_____

SURROUNDING HABITAT, FOREST TYPE/AGE_____
_____

SPECIES	ADULTS	EGGS	LARVAE	TADPOLES	OBS. REC	PHOTO #

COMMENTS/SKETCH

_____
_____
_____

PWFWCP AMPHIBIAN SURVEY DATA FORM Road survey

DATE_____START_____END_____OBSERVERS_____

WEATHER SKY clear | overcast (%) | rain_____
WIND calm | light | strong [Beaufort wind scale_____]
AIR TEMP_____24hr max & min_____

SURVEY#____
ROAD, direction of travel_____

START at Km_____UTM _____N_____E
END at Km_____UTM _____N_____E
MAP_____BEC ZONE_____variant_____

	MILEAGE			TIME	SPECIES	NUMBER of	
S	start	end	Km	total min	OBSERVED	INDIVIDUALS	OBS REC
1							

Notes (surrounding habitat, road conditions etc.)_____

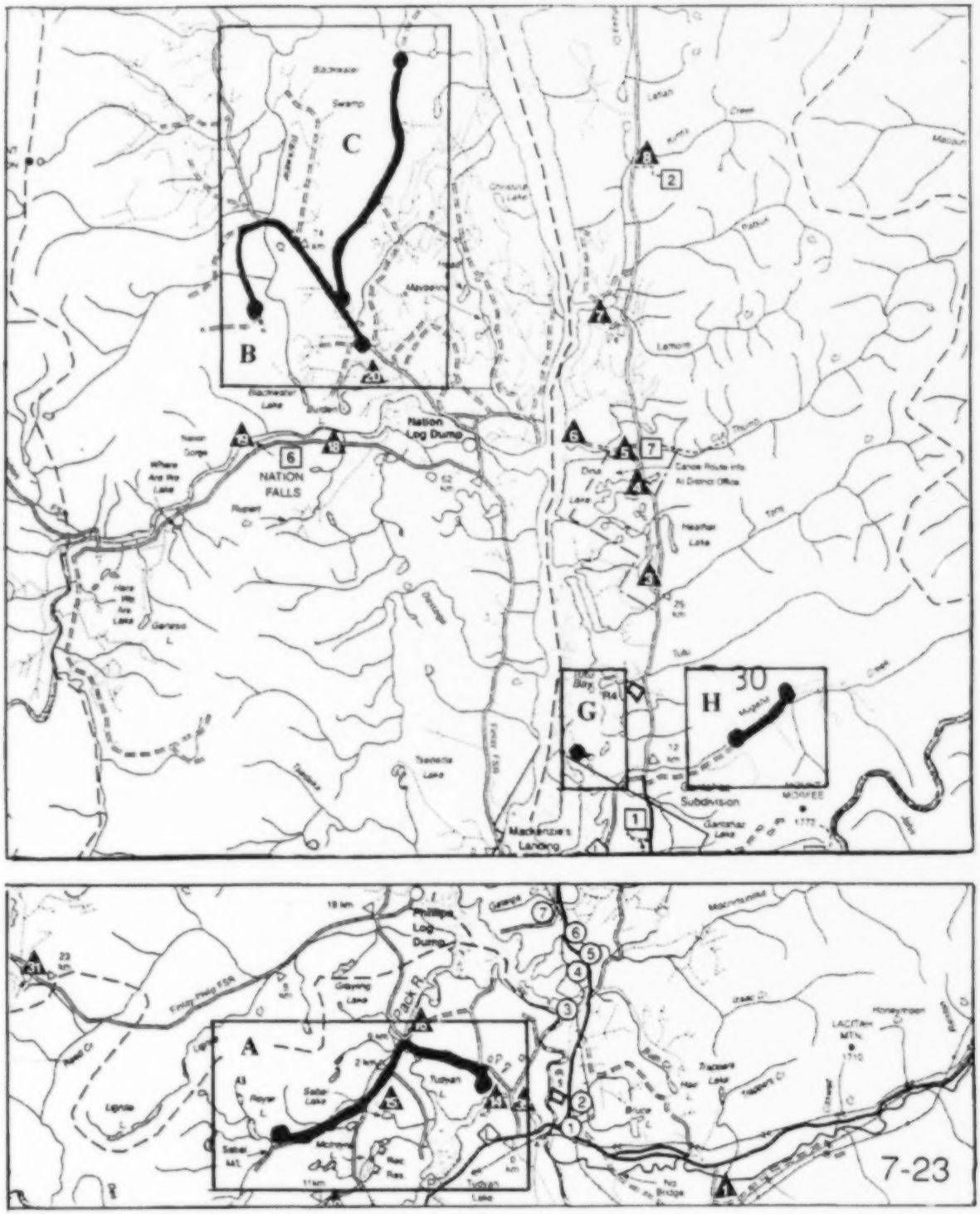
PWFWCP AMPHIBIAN SURVEY DATA FORM Observation record

REC #	SURVEY TYPE, #	SPECIES	SVL	MASS	COMMENTS	EASTG	NORTHG
1							

Appendix B

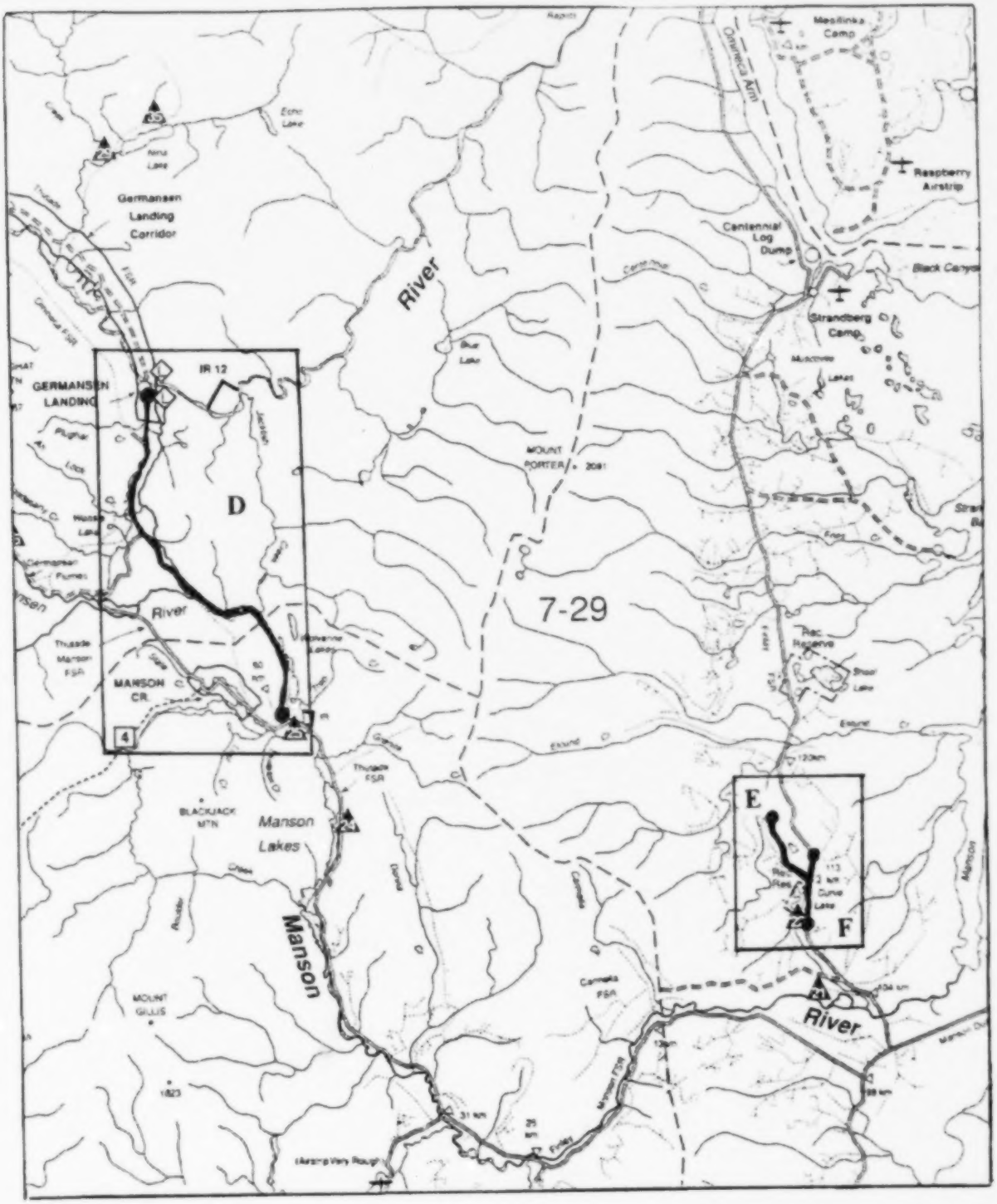
Location and general description of the amphibian reconnaissance survey routes identified, 11-21 May 1998.

BEC unit	Area	Route	Location	Description
SBSmk1	Sabai	A	From Tudyah Lake Rec. Site on Finlay FSR Mainline to km 19.5 on Sabai FSR	Route passed through clearcut blocks dominated by low shrub growth. Aquatic sites along the route were primarily ephemeral in basins, seepage, and riparian areas. There are numerous permanent ponds and lakes in the Sabai area.
SBSmk2	Blackwater	B	From Burden Lake Rec. Site on Finlay FSR Mainline to km 7.0 on Blackwater Lake (14000) FSR	Route was fringed with dense, mature coniferous and mixed wood forest; flanked by Blackwater Creek to the east. Several permanent ponds and lakes in the vicinity.
SBSmk2	Blackwater	C	9000 FSR (off Finlay FSR Mainline near Burden Lake Rec. Site)	Route passed through open, mature coniferous and mixed wood forest; flanked by 15 Mile Swamp and Blackwater Creek to the west.
BWBSdk1	Manson	D	From Wolverine Lake Rec. Site on Finlay Manson FSR to Germansen Landing	Route traversed a variety of habitats, including mature coniferous and mixed wood forest, old clearcut areas with young regenerating pine, open meadows, and riparian areas.
SBSwk2	Curve Lake	E	N39000 FSR (at km 113 on Finlay FSR Mainline; north of Curve Lake Rec Site).	Route accessed an extensive meadow complex several km long. The area included a permanent lake, and mature, upland, mixed wood forest.
SBSwk2	Curve Lake	F	Finlay FSR Mainline from km 107 to km 114 (adjacent to Curve Lake Rec. Site)	Route was a short section of a major road with adjacent clearcut blocks, coniferous and mixed wood forest, wet ditches, culverts and swampy riparian sites.
SBSmk2	Mugaha Marsh	G	Mugaha Marsh	Prolific marsh fringed with dense coniferous forest.
SBSvk	Mugaha Crk	H	Mugaha Creek FSR - km 6 (from Parsnip FSR Junction) to km 11.3	Route was a steep, narrow road on exposed clay and bedrock; it traversed mixed wood forest and recently clearcut blocks. No surface water within sight of road.
BWBSmw1	Dunlevy	I	Dunlevy Road to Dunlevy Creek	Open, dry, agricultural area with upland coniferous forest and a few ephemeral ponds on private fields.
SBSwk2	Gaylard Crk	J	Johnson FSR from 49 km to 65 km (Carbon Lake Rec. Site).	Route passed through dense, mature pine and spruce forest with several riparian areas, marshes, and lakes.
BWBSmw1	Johnson	K	Johnson FSR, from km 0 to km 16.5	Route traversed lush, open habitat with abundant cow-parsnip *(Heracleum lanatum)*, and mature coniferous forest. Deciduous growth was prevalent along seismic cutlines and utility right-of-ways. There were numerous ephemeral and permanent ponds, seepage, and riparian areas.



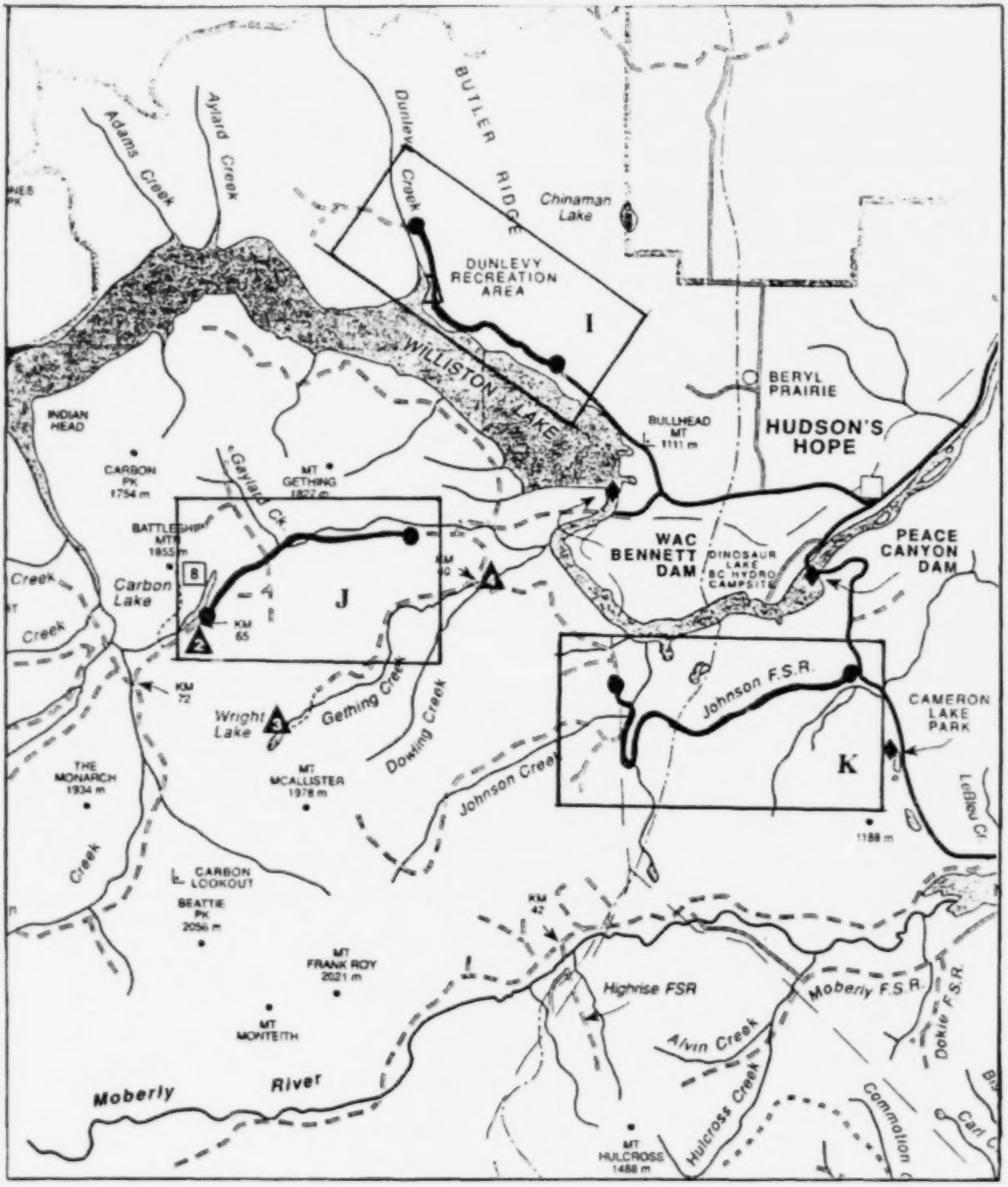
Sabai, Mugaha Marsh, Mugaha Crk, and Blackwater survey areas (routes A, G, H, B, C).
Mackenzie Forest District Recreation Map (South), March 1994.

0 3 6 km



Manson and Curve Lake survey areas (routes D, E, F).
Mackenzie Forest District Recreation Map (South), March 1994.

0 3 6 km



Dunlevy, Gaylard Crk, and Johnson survey areas (routes I, J, K).
Dawson Creek Forest District Recreation Map, January 1996.

0 3.4 6.8Km

Appendix C

Aquatic survey site descriptions and glossary of terms describing wetland types.

Table 1. Site descriptions for aquatic surveys conducted in Biogeoclimatic Ecosystem Classification (BEC) units within the Parsnip and Peace regions of the Williston Reservoir watershed, 11-21 May 1998.

BEC unit	Route (Survey Area)	Site	Wetland type[1]	Size[2] (ha)	Water Temp(°C)
SBSmkl	A (Sabai)	1	channel with culvert	2	9
		6	channel and seepage area	1.5	10
		11	non-vegetated shallow basin	0.08	19
SBSmk2	B (Blackwater)	1	mixed shrub shallow flood basin	0.56	13
		3	lake and peripheral fen	15	18
		4 *(i)*	non-vegetated shallow basin	<.01	12
		4 *(ii)*	non-vegetated shallow basin	<.01	12
	C (Blackwater)	1	coniferous treed wetland	0.25	16
	G (Mugaha Marsh)	2	basin marsh	24	22
SBSwk2	E (Curve Lake)	1	pothole bog and wet meadow	24	10
		3	wet, grassy meadow	225	18
		7	lake with fringed bog/fen	30	16
	F (Curve Lake)	1	grassy, closed shallow basin	0.16	14
	J (Gaylard Creek)	1	grassy marsh with wide channels	6	15
		3	shallow basin marsh	10	20
BWBSdkl	D (Manson)	1	wet meadow with narrow channels	25	8
		2	closed shallow basin	0.02	17
		4	grassy, linked shallow basin	0.08	18
		10	ditch	0.03	14
		11	shallow basin, peripheral marsh	0.50	16
BWBSmwl	K (Johnson)	4 *(i)*	non-vegetated closed basin	0.03	18
		4 *(ii)*	non-vegetated closed basin	0.03	18
		4 *(iii)*	non-vegetated closed basin	0.06	24
		6	linked basin (dammed by beaver)	0.20	12

[1] Wetland type nomenclature based on Mackenzie and Banner, draft.
[2] Observer estimates of total wetland area, not total area searched.

MacKenzie and Banner (Draft, 1998) describe a combination of two classification systems which can be applied specifically to wetlands and related ecosystems. The following definitions are extracted from their report.

Bogs and fens	Bogs are shrubby or treed, nutrient-poor peatlands with distinctive communities of ericaceous shrubs and Sphagnum hummocks in highly acid and oxygen-poor soil conditions. Fens are peatlands with groundwater flows that maintain relatively high mineral content, and are dominated by non-ericaceous shrubs, sedges, reeds and brown mosses. Long-term successional sequences in peatlands are from fens to bogs, thus many peatlands contain features of both.
Swamps	Occur on sites with a flowing, semi-permanent water table near the surface. Dominated by tall shrubs and trees.
Marshes	Shallowly flooded mineral wetlands dominated by emergent grass-like vegetation. Fluctuating water depth is typical; exposure of substrate in late season or during dry years is common. Marshes characteristically show elevationally banded or mosaic surface patterns composed of pools or channels interspersed with clumps of emergent sedges, grasses, rushes, or reeds.
Wet meadows	Develop on periodically saturated but seldom inundated mineral soils. Source of water is usually runoff and seepage water from surrounding basins. Herbaceous vegetation generally has an overall grassy appearance and is comprised of various mixtures of grasses, low sedges, rushes and forbs.
Lake	Water body >8 ha in size with wave-formed or bedrock shoreline and depths >2 m in deepest part of the basin (at low water).
Pond	Deep water body within a wetlands <1 ha in size
Shallow water	Occurs where standing water is <2 m deep in mid-summer. Dominated by rooted, submerged and floating aquatic plants that are adapted to permanent flooding. A shallow water body is referred to as a pool.
Linked basin	Basin receives water from upland and an inflow stream; excess water flows through an outflow. Includes wetlands along slow streams where there is little or no erosion or sedimentation.
Closed basin	Basin receives water from surrounding upland only; has no inlet or outlet channel.
Terminal basin	Basin receives water from upland and an inflow stream; no outlet.
Pothole	Wetland system is dominated by a central water body.
Channel	Open water course through a wetland.
Fringed	Wetland system is comprised of 2 features, with one occurring only on a peripheral fringe.
Peripheral	Area adjacent to upland

Appendix D Mass and length measurements of captured amphibians.

Aquatic survey site	Species	SVL (mm)	Mass (g)	Comments
A6	BUBO	22		juvenile
A6	BUBO	23		juvenile
A6	BUBO	22		juvenile
A6	BUBO	28		
A11	BUBO	100		
B3	BUBO	17		juvenile
B3	BUBO	17	1	juvenile
B4	BUBO	19	0.5-1.0	
Blackwater Lake (14000) FSR, near site B1	BUBO	86	62	very bright green observed on road after dusk
Blackwater Lake (14000) FSR, near site B1	BUBO	100	98	dark green observed on road after dusk
D4	RASY	55	14	
G2	BUBO	4-5 mm		tadpoles; tail is 5-6 mm
G2	BUBO	65	29	spotted legs, bright stripe
G2	BUBO	16	0.5	very olive green
G2	BUBO	21	0.5-1.0	
K4i	RALU	67	25	leg length (vent to toe) 11.3 cm
K6	RASY	22	2.0	

Appendix E Bird species heard during amphibian breeding call surveys.

Sabai 11 May	Blackwater 12 May	Manson 13 May	Curve Lake 14 May
ruby-crowned kinglet	ruby-crowned kinglet	ruby-crowned kinglet	ruby-crowned kinglet
solitary sandpiper	northern flicker	kingfisher	junco
robin	robin	chickadee	greater yellowlegs
varied thrush	red-necked grebe (pair)	yellow-rumped warbler	tree swallow
red-breasted nuthatch	orange-crowned warbler	bufflehead (pair)	Bonaparte's gull
orange-crowned warbler	chipping sparrow	robin	common loon
	winter wren	yellow warbler	northern shoveler
common snipe	red-breasted nuthatch	solitary sandpiper	goldeneye
barred owl	raven	red-winged blackbird	common snipe
saw-whet owl		northern flicker	northern flicker
solitary sandpiper	hermit thrush		winter wren
2 songbirds	Canada goose	ruffed grouse	red-breasted nuthatch
	saw-whet owl	gulls	raven
	great horned owl		song sparrow
	sandhill crane?		mallards
			warblers
			ruffed grouse
			common snipe
			robin
			barred owl

Mugaha 19 May	Gaylard 20 May	Johnson 21 May
white-crowned sparrow	ruby-crowned kinglet	solitary vireo
Swainson's thrush	northern flicker	mallards
northern waterthrush	chipping sparrow	snipe
sora	junco	ruffed grouse
common snipe	red-breasted nuthatch	hermit thrush
robin	mallards	whiskey jack
Canada goose	sora	
green-winged teal	Canada goose	Swainson's thrush
	gray jay	hermit thrush
	varied thrush	robin
	white-throated sparrow	white-throated sparrow
	Barrow's goldeneye	snipe
	red-winged blackbird	sora
	robin	saw-whet owl
	northern waterthrush	
	snipe	
	sora	
	mallards	